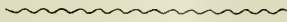


are congeneric without doubt, and *Blepharosteres agilis* is an *Ablepharus*, but it differs from *A. pusillus* in its much longer body. In *A. agilis* the fore limb does not nearly reach half way to the thigh and the hind limb barely reaches half way to the axil. In *A. pusillus* the fore limb reaches fully half way to the thigh or rather more and the hind limb two-thirds of the way to the axil. In the former the third and fourth toes of the fore foot are about equal in length, in the latter the third finger is decidedly the shorter. Under these circumstances I think it probable that *A. pusillus*\* is a distinct species and that *A. agilis* is probably distinct from *A. Brandti*, Strauch.



XX.—*The Evidence of past Glacial Action in the Nágá Hills, Assam.*

By Major H. H. GODWIN-AUSTEN, F. R. G. S., F. Z. S.

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With Plates X—XIII.

When carrying on the survey operations in the Khási Hills, I was more than once led to think that glacial action had played a part in the denudation of some of the valleys ; but the traces of such action were so slight that I hesitated to notice them. However, when writing the paper on the West Khási Hills which was published in this Journal in 1869, I alluded to the subject, with reference to the valley near Mokarsa, under the Maotherichan ridge. When mapping the Jatinga valley, I met with lines of heavy subangular débris, skirting streams from the north side of the high ridge the west extremity of the Burraill running thence to Asálu. Under and to north of the peak of Mahadeo, there is a terminal mass of transported material near where the Naga village of Garilo formerly stood. On the north of the Shillong peak, the highest part of the Khási Hills, skirting the sides of the “Umshirpi” stream, are to be seen the remnants of deposits for which it is difficult to account, unless we bring in the agency of ice, or large melting snowbeds. The “Umshirpi” has cut a deep gorge through the altered sandstones below the point where the road from Cherra Poonjee crosses it, and here takes a very sharp bend ; since its original excavation, a bed of water-worn boulders has filled the valley, and caps the spur round which the stream winds, and is seen again in the road-cutting on the right bank quite 25 feet above the present stream, as one proceeds to the Artillery barracks from the station side, shewing clearly it was once continuous, and has since

\* *A. pusillus* is figured in the ‘Zoology of Persia,’ Pl. XXVII, fig. 1.

been removed. Such a bed of transported material would again be found at this point, if large snow beds, or small glaciers were to be formed on the slopes of the Shillong peak, where the Umshirpi takes its rise, so as to produce a greater aqueous action, and sudden rushes of water. Yet I did not consider myself quite justified in attributing such appearances to more than the former greater intensity of aqueous action alone, especially on so low a latitude as  $25^{\circ} 30'$ .<sup>\*</sup> However, during my last expedition into the same range further east, where it rises to nearly 10,000 feet, it was highly interesting to find the most unmistakeable signs of former considerable glacial action. By any one who has traversed a glaciated region, the slightest evidence of such action is at once detected, which to the uninitiated eye might escape notice, but the moraines of the Burrail are of such dimensions, and so partake of all the characters of glacial action having once been in full force, as to strike the most unobservant as being peculiar. Rounding the base of the Burrail on the direct road from Sámágúting towards Manipur, after passing the village of Suchéma under the curiously shaped and conspicuous scarp of Sú-vé-nú-chi-ká, descending into the deep valley of the Zubza, on viâ Jotsáma and Phésáma, Kigwéma is reached, and shortly after coming in view of this last village, the path leads up the steep terminal slope and on to the level surface of the old moraine, on which our camp was soon pitched at an elevation of 5000 ft. The imagination could picture the time when the deep valley at the back, above which towered the cliffs and peak of Japvo (the point we had to ascend and observe from), was filled with the ice that had pushed and carried the large blocks of stone and earth forward. The summit of Japvo, a trigonometrical station, is 9,890 ft. above the sea, and the mean height of this eastern part of the Burrail, which here takes a bend to the south, is about 9,000. The Tertiary rocks, which first begin to rise above all the surrounding country near Asálu, dipping S E, continue, with a gradual elevation of the base of the series for 50 miles, until they attain their highest elevation near Japvo; the south-easterly dip changes gradually round to west, and presents a precipitous face at right angles to the direction of the main watershed:—the continuity of the Burrail as a high range is thus reduced suddenly from 9,000 to 5,000 feet, and the much older contorted clay shales and schists on which the Tertiary rocks unconformably rest are exposed. Along this east face there are several deep gorges, their streams joining the Zullo, which rises under the peaks of Ténépú and Khumho. Across the low saddle of the older series, which has a breadth of 5 miles, the newer rocks again come in, with a reversed dip, at Tellizo, and its base rises again towards the N E,

<sup>\*</sup> Dr. Wm. Hooker has noticed the glacial features in the Atlas Mountains; and Palgrave again south of the Caspian in lat.  $36^{\circ}$ .

forming with that strike the Kopamedza range. This sudden depression in the range, marked by the removal of the Tertiaries, stretches far away to the south, into the depression of the valley of Munipur, which is in fact the continuation of the same great lateral axis of elevation. The high N N E, S S W ridge of Tertiary sandstones, rising 7000—8000 feet, bounds the valley of Munipur for 80 miles, and marks its eastern boundary, coming in again at the Máphitel ridge, which bounds the valley on the east.

It is in the gorges draining to the Zullo river that the best examples of glacial action are to be seen, the moraine in the Gaziarurh being the largest. The tributaries of the Mazierh ravine under Japvo are numerous, and fall very suddenly from the ridge above; descending from the peak into the gorge, just below where they unite, and leaving the more confined part, and proceeding down the valley, the first signs of ice-action consist of narrow irregular terraces; until arriving at a lateral ravine at the north side of the valley, where a clearly defined small moraine projects out into the main valley of the Mazierh, to the level surface of its moraine, and would (when the glacier existed) have formed one of those little side lakes, so often seen in glaciated ground, just above the point of junction with a lateral and main glacier. Passing this side ravine, the path led along the flat surface of the moraine for half a mile, which widened gradually as the valley opened, and we then descended 200 feet into the bed of the stream. Enormous blocks shew out on the sides of the even-cut slope at an angle of  $45^\circ$ , and also lie near and in the bed of the present stream, the face of the slope being here very straight. The sketch (Pl. X) taken looking up the valley and one of the lateral moraine (Pl. XII, Fig. 1) will elucidate this feature. Just in a direct line opposite Kigwemah, the moraine ends at 4 miles from its source, with a terminal slope of  $45^\circ$ , and the stream descends rapidly to join the Zullo about 7 miles further down. The débris composing this mass of transported material having been derived from Tertiary sandstones all more or less soft, which have quickly broken up and become disintegrated, much of it must have been reduced to a state of mud and sand long before it arrived at Kigwemah, and hence it is that these moraines of the Naga Hills differ from those of the Himalaya and Alps, where the rocks are of various kinds, and often extremely hard, retaining their angular forms after travelling for a great distance. The level surface of the Mazierh moraine is now cultivated and terraced for the rice irrigation, and the sub-angular blocks and stones that formerly covered the surface have been used to build the walls of the terraces; the former distribution on the surface has thus been effaced, yet here and there collections of stones too large and heavy for removal by man still remain to shew that they moved down in the usual continuous line.

Proceeding south from Kigwémah, and reaching the next gorge at Zakameh, the scenery near it is most lovely, and the old moraine features

are very well displayed. At the point where the stream, the Gaziarurh, leaves the gorge, the broad flat expanse commences and extends down the valley for quite  $1\frac{1}{2}$  miles. After proceeding down and crossing it, the view from the next spur on the other side was most striking: the broad sweep of old moraine a quarter of a mile broad (terraced for cultivation) comes bending round to join the smaller one from the Kurúrurh; the two glaciers must have once met here, and the terminal cliff would have been just below the junction; the elevation is here 5,100 ft.\* I give a sketch of the moraine on Pl. XIII. The views on all sides were lovely, especially that up the gorge of the Gaziarurh: the soft hazy rays of light cast by the sun, setting behind the high range on the west, brought out in most lovely grey tones the receding steep spurs that bounded the glen.

Towards the upper part of the Zúllo near where the Kaburhi joins it, traces of old terraces of transported material are observable, and huge blocks of sandstone are seen here and there, all in the same level, resting on the clay shales (one of these blocks at about 4,800 ft. measured  $20 \times 18 \times 12 = 4,320$  cubic feet), and it is from among these transported blocks that the Nagas of Sopvumah select the monoliths and dolmens they erect in the villages along the crest of the ridge above, which is of clay shales.

Crossing the main watershed at its lowest part, we descend gradually to the head of the Barak valley, the physical aspect of which well deserves notice (Pl. XI). The river, here 3,800 ft. above sea level, flows with a very serpentine course through a broad level belt about  $\frac{1}{4}$  to  $\frac{1}{2}$  a mile in breadth, the greater part of which is or has been under rice cultivation. There are scarcely any trees on the hill slopes, and those few that exist are confined to patches on steep slopes bordering the river, where it bends in under the hills. Alluvial terraces are well developed both in the main valley and lateral branches. Under the village of Gnámih, the main accumulation of these deposits terminates, and below this they occur, now on one side of the valley, now on the other, extending into the narrow gorge of the river still further down where it takes a sharp loop-like bend of 6 miles, and it is evident that they once filled this gorge to a height of 130 feet; little, however, of the deposit is now left. In the more open part above, the upper level of the terraces is about 120 feet above the present level of the Barak, and they consist of strong coarse conglomerates and clay. The age of these

\* This altitude may be considered very low, when we know that the extension of similar action is not seen much below 4000 ft. in the N. W. Himalaya, on a more northern latitude; but there is every reason for supposing that during the last glacial period the general distribution of land and water was nearly the same as at the present time, and that the amount of moisture borne from the south and south-west must have then been very great, producing an enormous snow-fall deepening the valleys and forcing the glaciers to a lower level.

deposits there is every reason for supposing to be the same as that of the Japvo moraines, the result of a powerful river action, due to a heavy winter snow-fall,—all the main sources of the Barak lying in lateral valleys of the Kopamedza ridge at an elevation of 7—8,000 feet.

The character of the valleys that drain away through Manipur and eventually into the Irawadi, is intimately due to former effects of climate, during the period the changes I have above described were going on. These valleys and Manipur have at one time presented the appearance of a chain of lakes, now dry, the only remnant in Manipur itself being the Loglak Lake, now of small dimensions; a description of one such tributary valley will suffice for all,—and I am informed by Dr. J. Anderson that like characters are to be seen in the country towards Yunan. On the water-parting of the Irawadi and Súrmah, one looks down on the Khongba flowing with sharp bends through a broad almost level valley. The steep slopes from the Kouprú ridge on the west terminate some two miles from the base of those on the east, and a very gradual nearly level surface of water-worn detritus covers the intermediate ground, through which run four streams from the ridge above-mentioned.

The valley on the east is bounded by a low ridge of only some 300 feet above its bed, which gives off to the east spurs rising to 1000 feet. Further down the valley, 6 miles from the watershed at Kaital-Mambi, a collection of detritus (mostly angular) forms a terrace about 50 feet above the stream, and is the termination of the long talus given off by the deep ravines on the flank of the Koupru peak, which here rises to       feet some       feet higher than the ridge to its north. This talus extends close up to the eastern side of the valley and undoubtedly at one time abutted on its eastern spurs forming a lake above, subsequently drained by the stream cutting its way round their present base, a process which would have commenced directly the formation of talus from Koupru ceased with the change into present climatic conditions.

A sketch (Pl. XII, Fig. 2) of the Kaital-Mambi lake bed from the watershed is given in illustration of the above features.

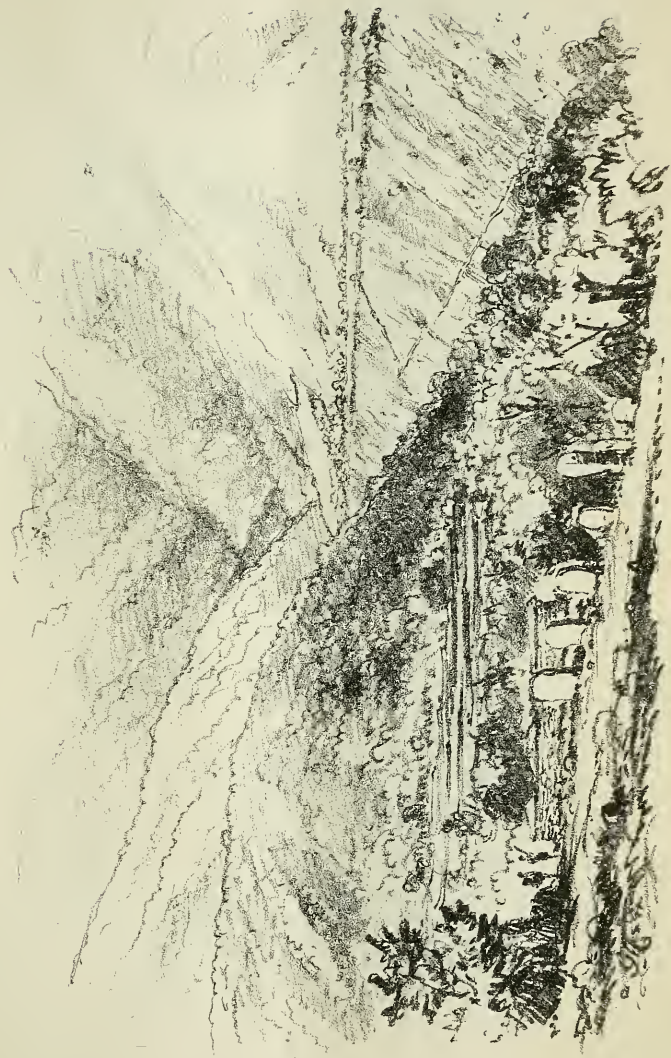




Photocographed at the Surveyor General's Office Calcutta

### MAP OF PART OF THE DAPLA HILLS

Illustrating Major Godwin-Austen's paper on the Geology of the Dapla Hills.



Engraved at the Surveyor General's Office, Calcutta.

MORaine IN MAZIERE RAVINE, NAGA HILLS.



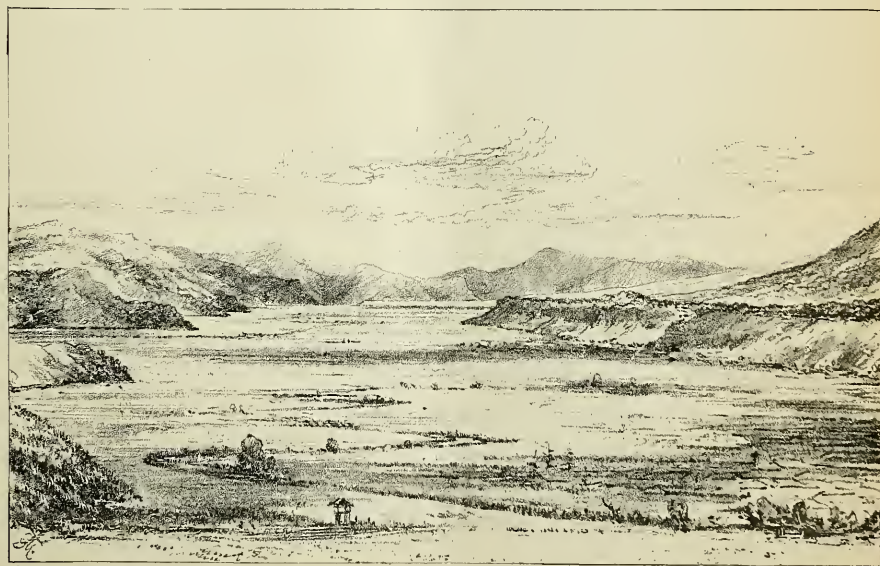
Surveys of the Surveyor General's Office Calcutta

ALLUVIAL TERRACES---HEAD OF BARAK VALLEY.





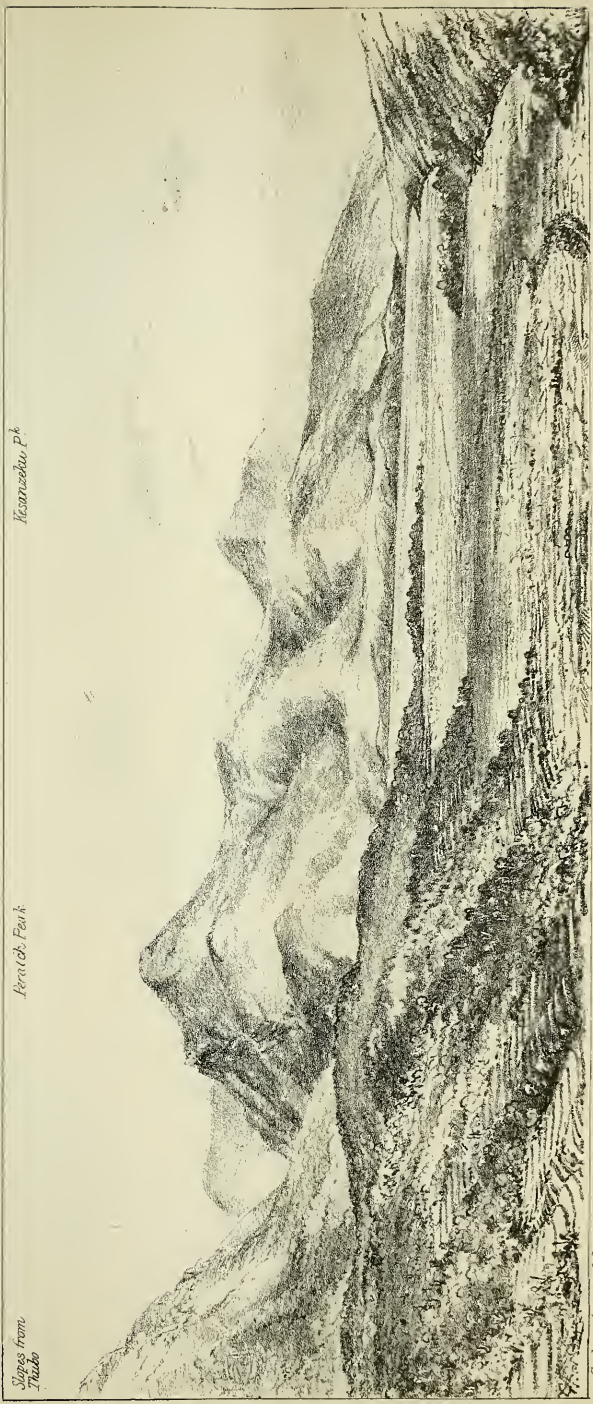
(Fig 1) LATERAL MORAINÉ. MÁZIERH RAVINE. NÁGÁ HILLS.



Godwin-Austen Del.

Maclure & Macdonald Lith

(Fig 2) LOOKING DOWN THE KHONGBA VALLEY. MUNIPÚR. (Old Lake Bed)



*Slopes from  
Trakob*

*Sketch by Fook*

*Konzoohu P<sup>h</sup>*

*Codwin Austen del.*

*MacLure & Macdonald Lith.*

GAZIA RURI MORAINÉ, near ZAKAMÉH, NAGA HILLS.